ciated by "modern Goths," and, therefore, that there was ample room for improvement in its modern adaptation. It was also a style which might be expected to last some time longer, and probably be always retained in church architecture. **

ST. DUNSTAN'S IN THE EAST.

This church has been recently repaired and re-decorated under the direction of Mr. Tite. The interior was rubbed with stone, the bosses of the groins illuminated, the woodwork cleaned, and the outside of the tower pointed and repaired. It was closed for five months, and was re-opened on the 16th of November last.

The church which stood on this site originally, of ancient date, was damaged by the great fire of 1666, and was in part-rebuilt by Sir Christopher Wren.

In 1810 the edifice had become much dilapidated, the walls of the nave being thrust out by the roof, and various ties were introduced. It was found, however, that nothing could be done effectually, and the first stone of the present church, designed by Mr. Laing,* to accord with Wren's tower, was laid on the 26th of November, 1817. It is constructed externally of Portland stone, and, considering the period of its erection, is a creditable production. Engravings of the exterior and interior, are given in Godwin's "Churches of London," Vol. I.

Wren's spire, as most of our readers will remember, is a curious piece of construction, being supported on four arched ribs, springing from the angles of the tower, similar to the spire of St. Nicholas, at Newcastle-on-Tyne, which probably furnished Wren with the idea.† The details of the tower display our great countryman's want of knowledge of pointed architecture, or contempt for its proprieties. John Carter, in one of his papers on "Architectural Innovation," published in the *Gentleman's Magazine*, says "St. Nicholas's tower is so lofty, and of such a girth, that, to compare great things with small, our London piece of vanity is but a mole-hill to the Newcastle 'mountain,' the pride and glory of the northern hemisphere."

THE BURSTING OF A CAST-IRON TANK, AT THE LIVERPOOL AND HARRINGTON WATER-WORKS.‡

It was originally intended to comprise the discussion of this subject in one paper only, but being deeply impressed with the belief of its importance in a practical point of view, we became aware that it required a fuller consideration than space would allow in one number of The Builder; we, therefore, resume the investigation, in the hopes that further inquiries may tend to throw some light on the cause of the accident, and serve as an example for conducting the calculations in other cases of a similar nature.

It is not the mean pressure of the water that ought to be taken into account in estimating the strength of the containing vessel, for since that occurs at the centre of gravity of the surface pressed, it is not of sufficient intensity to be made a criterion for judging of the general strength within the limit of safety, the mean on the lower half of the depth being much greater than that on the upper half. Neither is it the body of water contained in the vessel that leads us to the determination of the strength, for by the very nature of fluidity, the pressure is the same whether it be propagated by a film of one inch in thickness, or by a mass of one mile, or one thousand miles in extent. This is manifest from the circumstance of the pressure on the upright surface being expressed in terms of the dimensions of that surface, without reference to a third dimension, which is the characteristic of solidity; the equation which represents the pressure on a rectangular surface, involving only the length and breadth of that surface, which in the present instance we shall call the length and depth, because the one is horizontal and the other vertical.

The equation for pressure on an upright rectangular surface, when expressed in a specific form, is as follows, viz.:—

pressure = ½ *length* × *depth* × *depth* . . . . (A)

This equation represents the pressure when expressed in cubic feet of the fluid, and since one cubic foot of water weighs 62½ lbs., the pressure in pounds becomes

pressure = 31·25 *length* × *depth* × *depth* . . . . (B)

But in large surfaces where the pressure is very great, it is often more convenient to have its magnitude expressed in tons, and for this purpose the specific equation is

pressure = 0·01395 *length* × *depth* × *depth* . . (C)

If we assume the 36th foot along the side of the vessel; that is, the middle foot of the length, or 35 feet from each end, and estimate the pressure on each foot of depth considered separately, the variation of pressure from the top to the bottom of the vessel will thereby become manifest. Any one foot along the length would answer equally as well, but we have chosen the middle one as being that which includes the centres of magnitude and gravity of the surface, and likewise another point of very great importance which we will presently have occasion to consider.

The following tablet exhibits the pressure in cubic feet of water, and in pounds avoirdupois, for every foot of descent throughout the depth of the vessel; the same pressures being uniform on each equal portion of the upright surface.

TABLE OF PRESSURES.

Depth.	Cubic feet.	Pounds.
1	0·5	31·25
2	1·5	93·75
3	2·5	156·25
4	3·5	218·75
5	4·5	281·25
6	5·5	343·75
7	6·5	406·25
8	7·5	468·75
9	8·5	531·25
10	9·5	593·75
11	10·5	656·25
12	11·5	718·75
13	12·5	781·25
14	13·5	843·75
15	14·5	906·25
16	15·5	968·75
17	16·5	1031·25
18	17·5	1093·75
19	18·5	1156·25
20	19·5	1218·75

And if all the numbers in the second and third columns be summed up, we shall have 200 cubic feet, and 12,500 lbs. for the pressures on 20 feet in depth, and 1 foot in length of the surface of the vessel; being the same numbers as would arise by the application of the equations (A) and (B).

If we take the arithmetical means between the tabular numbers corresponding to the 10th and 11th feet in depth, we will find them to be 10 and 625 respectively; that is, the pressure on that foot of surface in the order of descent which is made up of the lower half of the 10th foot and the upper half of the 11th, is equivalent to the weight of 10 cubic feet of water, or 625 lbs. But if we take the means of the uppermost ten numbers, and also those of the lowermost, we shall find them to be 5; 312·5; and 15; 937·5; that is 5 cubic feet of water and 312·5 lbs., the means of the uppermost division, and 15 cubic feet of water and 937·5 lbs., the means of the lowermost; the means of both being 10 cubic feet of water, and 625 lbs, the same as before.

Let this suffice for the mode of reasoning for the pressure to be sustained; and next, for that pressure which is to be taken as a guide to the determination of the strength necessary to resist the accumulated pressure of the water.

We have seen that the mean pressure on a square foot of surface, at one-fourth, one-half, and three-fourths of the depth, are 312·5; 625, and 937·5 lbs., respectively; but it is obvious that neither of these can be taken as the mean from which to calculate the equivalent resistance; there is, however, a point where such a mean exists, and this point has by the writers on mechanics been denominated

THE CENTRE OF PRESSURE.

The *centre of pressure*, upon any plane surface, is that point in the plane to which if the total pressure were applied, its effect upon the plane would be precisely the same as when it is distributed unequally over the whole surface according to the natural laws of fluid pressure; or it is that point in the plane into which we may conceive the whole pressure to be accumulated; or it is that point to which, if a force be applied of equal intensity as the total pressure, but acting in a contrary direction, that force would exactly balance or sustain the pressure. From these definitions of the centre of pressure, it is evident, that a knowledge of its position, is of the utmost importance in every inquiry respecting fluid resistance.

The upright side of the tank at the Liverpool and Harrington water works would, if full, have been pressed with a force equivalent to 887500 lbs., and this force, as we have seen in the preceding table, is unequally distributed over the surface, the higher parts not being so much pressed as those that are at a greater depth, and consequently, the efforts of all the partial pressures may be conceived to be united in some particular point which is nearer to the bottom than the top of the vessel, and this is the point which we have termed the centre of pressure.

If, therefore, to this point, a force equivalent to 887500 lbs. be applied, it will have the same effect in straining the upright surface or side of the tank, as was exerted by the water when unequally distributed over it, not precisely indeed in the way of bulging out the parts, but in overturning it, supposing it to be moveable on hinges about the lower edge. And if to the point here referred to, we apply the same force of 887500 lbs. in a contrary direction to that of the pressure of the water, this force and the pressure of the water being equal and opposite, will destroy each others effects, and the side of the vessel will retain its upright position in the same manner as if it were not pressed at all.

It is foreign to our present purpose to give a rule for determining the position of the centre of pressure in all cases, or for surfaces of different forms; it would indeed be extremely difficult to do so, as a general investigation requires a higher order of mathematics than is recognised in the pages of The Builder, and would require more space than can be allowed in the present instance; there is, however, no occasion for entering into a general investigation of the subject, since the rule for the rectangular plane is simple and well known, and that is the case which directly applies to the form of surface now under consideration.

The writers on mechanics have shewn, that if any plane which is anyhow immersed in, or in contact with a non-elastic fluid, be produced till it intersects or coincides with the surface of the fluid, and if the line of common intersection of the two planes be considered as the axis of suspension; then the centre of oscillation or percussion of the plane, as it is supposed to revolve about that axis, will be in the same point of the plane as the centre of pressure sought. For let a straight line bisect the surface of the plane vertically; then, if the percussive forces of every point of that line be as the pressures exerted on those points, it follows that the centre of percussion must be the same as the centre of pressure; for the percussive force of any point in the above-said line, is as the velocity of that point, and the velocity is as the distance from the axis of suspension; consequently, since the percussive forces of the several points in the line are as their respective distances from the axis of motion, and since these lines are respectively perpendicular to the surface of the water, and therefore measure the pressures on the several points of the vertical line, it follows that the percussive forces are as the pressures on the several points, and for this reason the centre of percussion or oscillation is the same as the centre of pressure.

Now, it is a well known fact in the doctrine of mechanics, that the centre of percussion in a rectangular plane, having its upper side for the axis of suspension, is in the straight line which bisects the plane perpendicularly, and distant from the axis by two-thirds of the bisecting line.

If, therefore, we conceive the upright side of the tank to be the plane in question, its upper edge, when full of water, will be the axis of suspension, and the position of the centre of pressure will be in the vertical bisecting line at two-thirds of the depth of the vessel; then, a straight line drawn through this point parallel to the horizon, and ranging

* Who designed the Custom House. His son is an engraver on wood, whose works are well known to the readers of this journal.

† An engraving of St. Nicholas's church and a descriptive account of the structure, will be found in the first volume of The Builder, p. 231.

‡ See p. 16, ante.